ACSM Bulletin
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ACSM BULLETIN INTERVIEW WITH

Charles W. Challstrom

Is a plan based on changing workforce, more efficient technology, and broader user community the answer to NOAA/NGS's new role in the surveying community? The Director of the National Oceanic and Atmospheric Administration's Geodetic Survey is convinced it is.

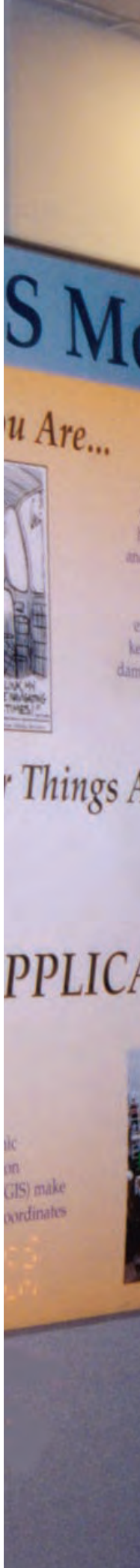
ACSM BULLETIN EDITOR:
How and into what areas do you see NOAA/NGS evolving in the next five to ten years?

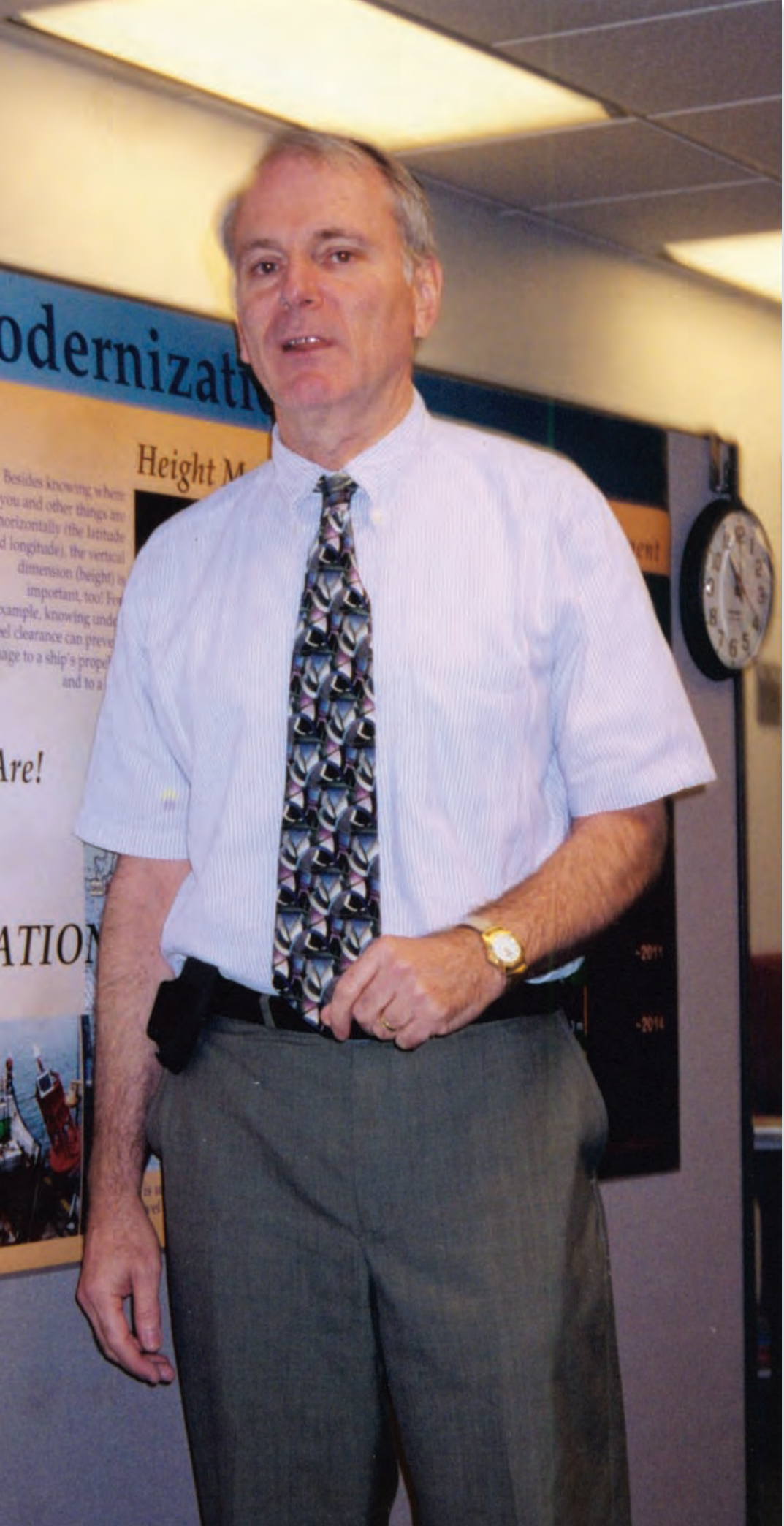
DIRECTOR CHALLSTROM:
Technology, young people replacing the retiring workforce with a new set of skills, and the community that uses NOAA/NGS products all demand that we change the way we do business. In essense, NOAA's NGS is becoming an agency with a broader set of responsibilities toward a broader user community. Change is exciting; these are exciting times for us.

ACSM BULLETIN EDITOR:
The primary user community for NOAA's NGS has always been the surveying community. Will there be a change in the near future?

DIRECTOR CHALLSTROM:
As a matter of fact that change has already taken place, thanks to GPS. Except for points in the National Spatial Reference System, the National Geodetic Survey no longer needs to serve as provider of centimeter-level position measurements. The state and local governments and the private sector have been doing this quite well for some time now, and very successfully.

Our role is to enable them to do this kind of work.. to build further this outside capacity, because things have changed dramatically in this field. You'll see this shift not only in the type of equipment being used for positioning work, but also in the variety of uses the information supports. We find ourselves developing analytical models and tools that would take the best advantage of the data, rather than being concerned with infrastructure





and actual positioning work. We are becoming the "enablers", "trainers," instead of the "doers." The future lies in working with others; it is imperative that we focus on connecting with those in the public and private sectors, and in colleges and universities, to share in the technology of advanced surveying and mapping.

ACSM BULLETIN EDITOR: You credit GPS with having revolutionized the surveying business. In which of NGS collaborative programs is the spin-off of this development particularly noticeable?

DIRECTOR CHALLSTROM: The Continuously Operating Reference Station (CORS) network is the most remarkable collaborative program in that respect. NGS and our parent NOAA collectively operate only about 20 percent of the CORS in the system. The rest are operated by highway departments and other state government agencies, by private companies, and a few are at colleges and universities. I even know one that's run by a high school. All the installations operate to a rigorous set of guidelines and specifications. NGS verifies the CORS data daily so that others who use them for positioning can do so with confidence.

The CORS network is growing; there are about 500 CORS operated by 140 organizations within

the U.S. and contributing to the national data positioning network. Sixty other countries operate similar networks; we exchange our data through an international GPS service to ensure that our formats are consistent with one another and globally.

ACSM BULLETIN EDITOR: How and where are CORS data used?

DIRECTOR CHALLSTROM: CORS is set up to be a post-collection data processing system; the processing is more vigorous than instantaneous processing, yielding positions as good as two to three centimeter accuracy...better than an inch, if needed. These results open up a range of applications whether it be more accurate positioning of water transport systems, where the vertical is a key element, or in doing property surveys. There are private companies out there using CORS data to position all of their activities, because of the element of accuracy that characterizes CORS.

ACSM BULLETIN EDITOR: NGS validates CORS data; what else is being done to enhance the use of CORS?

DIRECTOR CHALLSTROM: We created OPUS—an online positioning user service. OPUS makes it possible for individuals, as well as companies, to submit data they have collected to NGS via the Internet, and we provide a solution based on the best CORS data from three stations in their area, again via the Internet. The number of OPUS solutions rendered over

the past year or two has been amazing. More than 100,000 were enabled; fully 70,000 of those were in the last eight to twelve months. The solutions come with estimates of their accuracy—an added bonus. OPUS has proved to be a truly great tool, appreciated not only by surveyors in the U.S, but even some of the surveying done in Athens in preparation for the Olympics benefitted from OPUS. And, it may also be helpful in setting up CORS—same model, same approach—in Iraq.

ACSM BULLETIN EDITOR:
I keep hearing about "height mod" What is the future of that program?

DIRECTOR CHALLSTROM:
Right, height modernization is another nationally expanding program. "Height mod" has gained momentum in a number of states, and Congressional interest has led to some specified funding opportunities for collaborative State-NOAA/NGS projects. California and North Carolina were the first to use height modernization to demonstrate the advantages of using GPS for heights. It's not just the horizontal any more; now we can deliver centimeter accuracies in heights as well.

ACSM BULLETIN EDITOR:
Where and why is it important to have accurate heights?

DIRECTOR CHALLSTROM: Take agriculture, for example. Height modernization is enabling more accurate application of fertilizer and pesticides and more efficient use of water. Higher efficiency leads to lower costs of production—because losses can be obviated when one knows fields' elevations.

Another example where accurate heights contribute to agricultural efficiency is in plowing; GPS-guided farm equipment may sound fanciful—but it saves time. Fields are plowed faster when the blades know where to go deeper and mind the slope. This is again an efficiency issue; what's more, we have seen that if we improve agricultural efficiency, we are actually helping to protect the environment.

Another height modernization application that NOAA/NGS has been looking at concerns weather—particularly our ability to prepare for coastal storms.

Height modernization techniques have been used to survey hurricane evacuation routes. With better information about route slope and height, local emergency planners will know in advance which roads are likely to be flooded and which will stay above water.

Earlier this year, we completed an excellent collaborative project in Louisiana to prepare the state's coast for the upcoming hurricate season; the plan is to expand it to Mississippi, if funds become available. There are some projects in the pipeline that would bring the same capability to the entire Gulf Coast.

Besides planning for safe evacuation routes, it's also critical to protect the Gulf from soil erosion caused by strong tidal surges during coastal storms. The fringe land in some parts of the Gulf Coast have been sinking up to a half of a foot in a decade!

Advanced GPS capabilities offer great opportunities for floodplain mapping in general. That's the future, and all surveyors in this country should be aware of the various needs of National Flood Insurance Program for accurate heights. All properties built near actual or potential flood areas will require an elevation certificate. We look at this as the Social Security Act for surveyors.

There are tremendous opportunities here. Just imagine the amount of work generated if every homeowner who decides to sell their property has to obtain from a surveyor an elevation certificate before going to settlement. We are talking potentially tens of thousands of elevation certificates over the next few years!

We are working closely with FEMA and various surveying organizations to develop training for surveyors to enable them take advantage of this great opportunity.

ACSM BULLETIN EDITOR:
Something along the line of North Carolina's effort?

DIRECTOR CHALLSTROM: Congress has designated roughly $1 million a year for the last several years for work in North Carolina. Some of that funding has gone to support the state Geodetic Survey and one of the universities providing training workshops, but by far the largest chunk has been used for direct contracting with four firms in the private sector to conduct height modernization surveys, using NOAA/NGS guidelines. North Carolina's program has helped to clearly demonstrate not only the con-

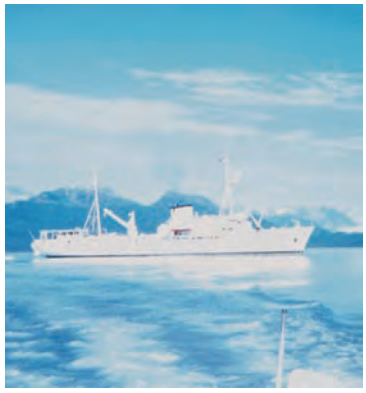
nection between height modernization and flood mapping, but also the need for all the pieces, including training, to be in place for successful "height mod" program implementation.

ACSM BULLETIN EDITOR:
How is the National Geodetic Survey helping small businesses enter the arena of floodplain mapping?

DIRECTOR CHALLSTROM: We encourage private business to conduct increasingly more control surveys using NOAA/NGS-perfected advanced GPS technology. To that end we have developed specifications and guidelines for such work and published them on our website to get feedback from surveyors. And don't forget OPUS—anybody who has data and needs to turn them into a solution has access to the service.

ACSM BULLETIN EDITOR:
Are guidelines for "height mod" the same as "bluebooking"?

DIRECTOR CHALLSTROM: Yes and no. "Bluebooking" is a long-standing term referring to the original color of the cover of the book NGS had for data certification. Somewhere along the way the process developed for submitting data to be included in the integrated national database came to be known as "bluebooking." We are working on streamlining the process, thus removing the burden that's been hampering bluebooking of GPS data so far. The aim is to automate the process, enabling faster, easier, and more user-friendly processing of data entering the NOAA/NGS database.



NOAA ship Surveyor in the Gulf of Mexico.[Source: www.photolib.noaa.gov]

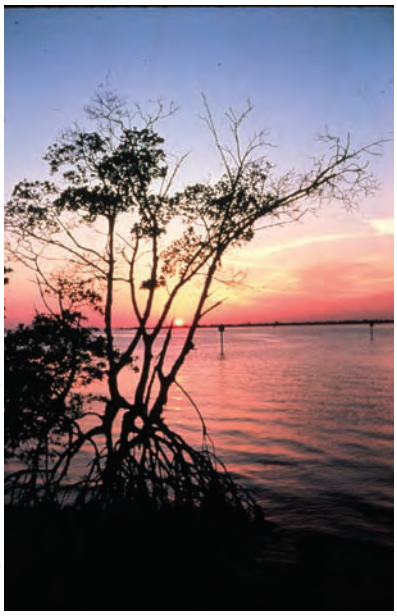
ACSM BULLETIN EDITOR:
Coastal mapping—how does advanced GPS technology contribute to this program?

DIRECTOR CHALLSTROM:
Within coastal mapping, NOAA/NGS' responsibility is to delineate the nation's shoreline as accurately as possible with current technology and feed the data into the nautical charts put out by NOAA.Our part of the organization—NGS—has been involved in coastal mapping since 1807, when the "Survey of the Coast" was established by Thomas Jefferson to "delineate with correctness the great arteries of this great country..." That was our original purpose—to position the shoreline for safe transportation.

Coastal zone managers need more and better information about runoff or subsidence in coastal areas for development planning purposes. We continue to "fill up the canvas" begun two centuries ago by Jefferson by utilizing a combination of positioning and remote sensing capabilities. Adding LIDAR—Light Detection and Ranging—techniques to the mix should yield highly accurate maps of the shoreline, as well as good predictive models of its characteristics under different climatic scenarios.

Accurate mapping and accurate positioning can play an enormous role in environmental preservation. One frequent aspect of restoration of the fragile coastal wetland areas is selecting the right type of vegetation. To do that one needs to have a fairly good expectation of what the tides will be and hence, the level of inundation—in other words, one needs accurate elevation and models

Setting up a GPS station atop Sawyer Island, 1999. [Source: www.photolib.noaa.gov]



Mangroves at the Keys...a fragile habitat. [Source: www.photolib.noaa.gov]

of the area. NOAA's National Geodetic Survey has been involved in a couple of restoration projects, most recently in the Fort McHenry project in the Upper Chessapeake where the aim was to mitigate the environmental impact of a large pipeline.

Another example where better surveying and mapping techniques help coastal planners and engineering firms to do their work more efficiently are large-scale development projects such as dredging the Nation's ports and harbors to improve shipping lines. The issue here is where to deposit the dredged out material and how to do it in an environmentally sensitive manner. NOAA/NGS' coastal mapping program has developed a capability for identifying areas that can best handle such deposits.

ACSM BULLETIN EDITOR:
Where else apart from the East Coast have similar projects been implemented?

DIRECTOR CHALLSTROM:
We have demonstrated these "combination mapping techniques on the East Coast, but also in the Gulf area, in the drainage area of the Mississippi, as well as on the West Coast, in the restoration of the Haliburton field area just north of San Francisco. Similarly, we put in good base control near Oakland to enable more accurate monitoring of the levels of water in the Port of Oakland in the San Francisco Bay. The port handles large container cargo, so they need to know what the clearance is above and under the vesel, how much load they put on the ships docking there, when they can sail out, taking advantage of high tide ... all these decisions depend on knowing what the water heights are.

ACSM BULLETIN EDITOR:
Information-on-wheels—is this something that NOAA/NGS may consider getting involved in?

DIRECTOR CHALLSTROM:
We are exploring possibilities of how to use the fact that cars can be accurately positioned with GPS for such applications as information sharing for safer public driving. For instance, the majority of new vehicles have on board temperature sensors capable of monitoring outside temperature. We recognize that if we can capture both the car's position and the outside temperature, then we may have a way of feeding more accurate local data into NOAA's Weather Service models. Information about road conditions captured by drivers and fed into local weather models will enhance predictions, especially during winter, about whether it's safe for us to be out there driving or staying away. We're working closely with the Federal Highway Administration and colleagues in the Weather Service to bring our positioning expertise to bear on improving road safety.

One issue that's of particular interest to us is how best to collect the relevant data from vehicles. An idea has come up to consider each participating vehicle as a "Cooperative Weather Observer." We have talked with some of the large trucking companies, and they are very interested in participating. So are some states which have gone ahead and launched pilot projects to explore options for utilizing data collected from moving vehicles.

Besides facilitating a kind of local road safety information service, the data could also be used by road maintenance staff for more efficient and cost-effective use of chemicals and other materials for road maintenance. If it is known when freezing conditions are likely, then one can better estimate the amounts of salt, sand, and chemicals needed, and whether or not to apply them ahead of a storm, all of which can lead to true public savings. And, the less chemicals put on the roads,the less environmental damage we'll have to deal with—so, your "information-on-

LAND SURVEYING/GEOMATICS PROFESSOR

Tenure track position will develop and deliver upper level classes leading to a Bachelor of Applied Science degree. This new program is the only one of its kind in Nevada, and instructor will be expected to teach through live instruction, interactive video, online courses, coordination with other instructors, and other methods as necessary. Based in Elko, courses will be upper-division only, targeting students already holding an Associates degree in surveying from other institutions.

Required:

- Masters degree
- Strong teaching and communication skills
- Background containing extensive land surveying and/or Geomatics.
- Nevada Professional land surveying licensure/ registration, or ability to obtain such within one year of appointment
- Three years work experience as a land surveyor or in closely related field.
- Ability to use and teach modern computer applications in land surveying.

Tentative list of courses:

GIS for Surveyors
Photogrammetry
Legal Description
Public Land Survey System
Geodetic/GPS Surveying
Construction Surveying (and Mine Surveying possibly)
Advanced Boundary Analysis
Computer Applications to Surveying(capstone course)

State benefits package includes NO state income tax, DC retirement plan with employees contributing 10.5% with matching 10.5% from employer, medical/dental/ vision plan, benefit time, 11 paid holidays, interest-free computer loans, and tuition waiver at all Nevada colleges for employee and family.

Visit Great Basin College at http://www.gbcnv.edu/hr for application.

wheels" has the potential to improve efficiency, help the environment, and, improve the safety on our roads.

ACSM BULLETIN EDITOR:
And last, but not the least, can you touch on two other trendy technological concepts—location-based services and the MIDAS project?

DIRECTOR CHALLSTROM:
As part of the Department of Commerce, we have been studying opportunities for perfecting the tools available to drivers for providing location-based information on local business and creating a national infrastructure of business information. Mapping constitutes a great part of location-based services, as does positioning. Location-based services are a growing business sector, and surveyors need to be aware that they are providing the foundation for it.

The MADAS project utilizes data from satellite-based sensing, i.e., GPS positioning sensors mounted in vehicles, and sensors embeded in roads to improve road and traffic safety. The project is coordinated and facilitated by State Highway Departments; we see an opportunity for assisting them with the sharing of updated positioning techniques.

ACSM BULLETIN EDITOR:
We have covered a lot of ground in this interview—from CORS to "height mod" to coastal mapping, to road safety. Is there one particular thought that you would like to share with surveyors and mappers outside NOAA/NGS?

DIRECTOR CHALLSTROM:
The impact of construction and engineering on the environment has become a major concern; developers, builders, engineering firms are asked to build into their projects precautionary measures. These can be more efficiently and more effectively executed with accurate surveying information. We at NOAA/NGS are striving to develop tools that would make the surveying data that are out there more accessible and shareable. We will be able to do this better if surveyors, for whom most of the technological and information tools we develop are intended, continue giving us their invaluable feedback on how things work in the field.

Post-Release Assessment of GEOID03

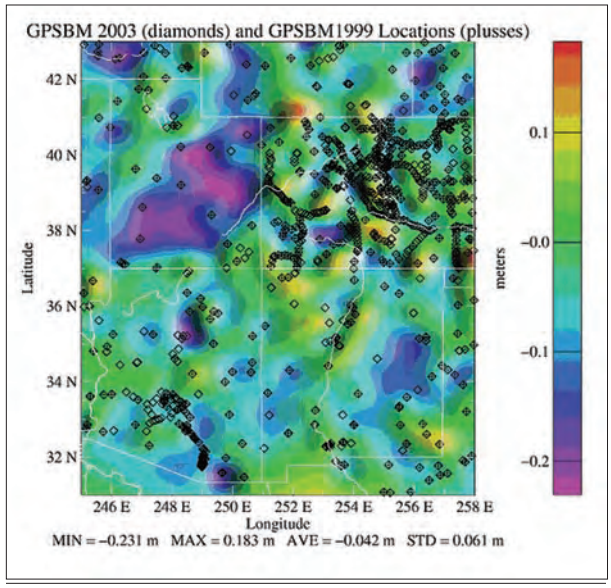
Daniel R. Roman

A new national geoid height model, GEOID03, was released at the end of last year. It utilized multiple positive-definite matrices in a Least Squares Collocation (LSC) model to determine a best fitting surface to 14,185 control points scattered across North America. This surface was used to create an optimal transformation between the NAD 83 and NAVD 88 datums. This model's development was covered in a discussion session at the ACSM Spring 2003 meeting and is also covered in *Surveying and Land Information Science* vol. 64, no. 3, pp. 153-162. Several questions about the reliability of the model were raised at the conference for some regions, specifically in the western states.

The control data consisted of A, B, and 1st order GPS on 1st, 2nd, and 3rd order leveling. The wide variety of accuracies of these data result in disparate spectral signals, which are poorly modeled using a single matrix in LSC (e.g., GEOID99). Hence, two matrices were used to capture the spectral character for GEOID03.

The benefit in multiple matrices comes from using different correlation lengths to capture both the short and long wavelength character of the systematic differences. Signal shorter than 400 km was simply treated as noise in GEOID99. GEOID03 captured signal down to 60 km, thereby reducing the amount of unmodeled signal. However, the data must have sufficient spatial extent to adequately capture the signal.

In western states particularly, the control data are much sparser. Station spacings over 60 km cause the short wavelength model not to work adequately and leaves only the long wavelength model. Because the GEOID03 long-wavelength model is 650 km while GEOID99 is is only 400 km, GEOID03 performs marginally worse than GEOID99 (< 1.0 cm) for such regions. The effect on the geoid is not visible, but the conversion surface has a slightly bubbly nature. This is because the conversion surface rises up to an isolated point from the broader, smoother regional field. This broader field is smoother for GEOID03 than for GEOID99 and omits more signal, resulting in the degradation in those regions (see image above).



GEOID03 and GEOID99 differences for western states with GPSBM2003 and GPSBM1999 data overplotted. Note that a number of significant (greater than 10 cm magnitude) features are associated where no control or only GPSBM2003 control data exist. The large spatial extents devoid of any control data (middle-eastern New Mexico and central Utah) create the largest differences.

There are two solutions: (1) refine the modeling technique and (2) add more data. Future models will employ three or more matrices to ensure that they will behave at least as well as GEODI99. The second issue requires the selective addition of data in remote (primarily western) regions. Mechanisms include the use of OPUS data collected at bench marks and redefining USGS bench marks onto the NAVD 88 datum. Improvement in the West must occur if a reliable geoid height model is to be devised for use everywhere.

[Dr. Roman is a Research Geodesist at NOAA's National Geodetic Survey, where he is responsible for the generation of geoid models. If you have any questions, call him at 301-713-3202 x161 or send an e-mail to dan.roman@noaa.gov.]